WHAT IS CLAIMED IS:

1. A method of reading information stored on a data storage medium comprising the steps of:

(a) exciting a luminescent data storage medium with an optical source to thereby cause said luminescent data storage medium to emit a fluorescent light signal, wherein said luminescent data storage medium comprises Al_2O_3 and wherein said optical source emits a read laser beam having a wavelength in the range of an absorption band of said luminescent data storage medium; and

(b) measuring said laser induced fluorescence light signal from said luminescent data storage medium, to thereby read said information stored on said luminescent data storage medium, wherein said luminescent data storage medium comprises:

a base material comprising Al_2O_3;

a first dopant comprising magnesium; and

a second dopant comprising carbon, wherein said luminescent data storage medium includes a plurality of at least one type of oxygen vacancy defect, and wherein said luminescent data storage medium includes at least one color center having: an absorption bands in the regions of 250±5 nm, 335±5 nm and 620±10 nm, an emission in the region of 750±10 nm, and a 80±10 ns lifetime.

2. The method of claim 1, wherein step (a) comprises exciting said luminescent data storage medium using a one-photon absorption technique without causing photo-ionization of the storage centers to thereby cause said luminescent data storage medium to emit a fluorescent light signal and thereby read said luminescent data storage medium non-destructively.

3. The method of claim 1, wherein step (a) comprises exciting said luminescent data storage medium using a simultaneous two-photon absorption technique without causing photo-ionization of the storage centers to thereby cause said luminescent data storage medium to emit a fluorescent light signal and thereby read said luminescent data storage medium non-destructively.

4. The method of claim 3, wherein said data storage medium is excited by light from said optical source having a wavelength about two times longer than the wavelength of the absorption band of said luminescent data storage medium.

5. The method of claim 1, wherein said read laser beam has a wavelength within an absorption band of Al_2O_3:C,Mg centered at 620±10 nm and wherein said fluorescent light signal has an emission band having a wavelength range of 620-880 nm, inclusive, and being centered at 750±10 nm.

6. The method of claim 1, wherein said fluorescent light signal is excited using light of the wavelength within an absorption band of Al_2O_3:C,Mg and centered at 250±10 nm and wherein said fluorescent light signal has an emission band having a wavelength range of 620 nm to 880 nm, inclusive, and being centered at 750±10 nm.

7. The method of claim 1, wherein said luminescent data storage medium includes at least one color center having: an absorption in the region of 435±5 nm, an emission in the region of 520±5 nm and a 9±3 ns fluorescence lifetime and at least one color center having: absorption bands in the regions of 335±5 nm and 620±10 nm, an emission in the region of 750±5 nm, and a 80±10 ns lifetime.

8. The method of claim 1, wherein said fluorescent light signal has a wavelength of 650 and 800 nm, inclusive, and centered at 750±10 nm.

9. The method of claim 1, wherein said read laser beam illuminates said luminescent data storage medium for the period of time between 1 ns and 10 μs.

10. The method of claim 1, wherein said read laser beam illuminates said luminescent data storage medium for about 100 ns.

11. The method of claim 1, wherein prior to step (a) said method further comprises the step of:

writing to said luminescent data storage medium with a write laser beam.

12. The method of claim 1, wherein information from said luminescent data storage medium is read from more than one layer at the different depths inside said luminescent data storage medium.

13. The method of claim 1, wherein step (b) comprises detecting said fluorescence signal using a confocal detection technique.

14. The method of claim 1, wherein said read laser beam is emitted by said optical source disposed in a read/write head and said optical read/write head incorporates spherical aberration compensation allowing for a diffraction limited spot at a depth of at least 10 microns.

15. The method of claim 11, wherein said read and write laser beams are each focused through a lens and said lens is used for writing information to and reading information from said luminescent data storage medium.

16. The method of claim 1, further comprising the step of:

moving said luminescent data storage medium with respect to said optical source and to a read position prior to said read laser beam exciting said luminescent data storage medium.

17. The method of claim 1, further comprising the step of:

focusing said read laser beam to a predetermined depth in said luminescent data storage medium.

18. The method of claim 17, wherein said read laser beam is focused by moving said luminescent data storage medium with respect to said read laser beam.

19. The method of claim 17, wherein said read laser beam is focused by adjusting the position of an optical pick-up head.

20. The method of claim 1, wherein said luminescent data storage medium is read for a read time equal to a read laser beam pulse length and wherein said luminescent data storage medium is a stationary data storage medium.

21. The method of claim 1, wherein said luminescent data storage medium is read for a read time equal to a ratio of a reading spot size with respect to the velocity of said luminescent data storage medium and wherein said luminescent data storage medium is a moving data storage medium.

22. A method of writing information to a data storage medium comprising the steps of:

providing a luminescent data storage medium comprising Al_2O_3; and

writing said information to said luminescent data storage medium with an optical source, wherein said luminescent data storage medium has an orientation of the optical *c*-axis parallel to the direction of the light propagation of said optical source.

23. The method of claim 22, wherein said luminescent data storage medium comprises:

a base material comprising Al_2O_3;

a first dopant comprising Mg; and

a second dopant comprising carbon, wherein said luminescent data storage medium includes a plurality of at least one type of oxygen vacancy defect.

24. The method of claim 23, wherein said luminescent data storage medium includes at least one color center having: an absorption in the region of 435±5 nm, an emission in the region of 520±5 nm and a 9±3 ns fluorescence lifetime.

25. The method of claim 23, wherein said luminescent data storage medium includes at least one color center having: an excitation and absorption bands in the regions of 250 ±5 nm, 335±5 nm and 620±10 nm, an emission in the region of 750±10 nm and a 80±10 ns fluorescence lifetime.

26. The method of claim 23, wherein said laser beam has a wavelength of 370 to 490 nm, inclusive.

27. The method of claim 23, wherein said optical source emits a laser beam having a wavelength of 390 nm.

28. A method of writing information to a data storage medium comprising the steps of:

providing a luminescent data storage medium comprising Al_2O_3; and

writing said information to said luminescent data storage medium with an optical source, wherein said luminescent data storage medium has an orientation of the optical *c*-axis perpendicular to the direction of the light propagation of said optical source and wherein the vector of polarization of said optical source rotates synchronously with the rotation of said luminescent data storage medium, and maintains the optical *c*-axis of the crystal parallel to the polarization direction of the optical source.

29. A method of reading information stored on a data storage medium comprising the steps of:

(a) exciting a luminescent data storage medium with an optical source to thereby cause said luminescent data storage medium to emit a fluorescent light signal, wherein said luminescent data storage medium comprises Al_2O_3 and wherein said optical source emits a read laser beam having a wavelength in the range of an absorption band of said luminescent data storage medium; and wherein said luminescent data storage medium has an orientation of the optical *c*-axis parallel to the direction of the light propagation of said optical source; and

(b) measuring said laser induced fluorescence light signal from said luminescent data storage medium, to thereby read said information stored on said luminescent data storage medium.

30. A method of reading information stored on a data storage medium comprising the steps of:

(a) exciting a luminescent data storage medium with an optical source to thereby cause said luminescent data storage medium to emit a fluorescent light signal, wherein said luminescent data storage medium comprises Al_2O_3 and wherein said optical source emits a read laser beam having a wavelength in the range of an absorption band of said luminescent data storage medium; and wherein said luminescent data storage medium has an orientation of the optical *c*-axis perpendicular to the direction of the light propagation of said optical source and wherein the vector of polarization of said optical source rotates synchronously

with the rotation of said luminescent data storage medium, and wherein said c-axis of the crystal maintains parallel to the polarization direction of the optical source; and

(b) measuring said laser induced fluorescence light signal from said luminescent data storage medium, to thereby read said information stored on said luminescent data storage medium.

31. A method of erasing information stored on a data storage medium comprising the steps of:

(a) providing a luminescent data storage medium comprising Al_2O_3, said luminescent data storage medium having said information stored thereon; and

(b) illuminating said luminescent data storage medium with an optical source to thereby erase said information, wherein said luminescent data storage medium comprises:

a base material comprising Al_2O_3;

a first dopant comprising magnesium; and

a second dopant comprising carbon, wherein said luminescent data storage medium includes a plurality of at least one type of oxygen vacancy defect, and wherein said luminescent data storage medium includes at least one color center having: an absorption bands in the region of 250±5 nm, 335±5 nm and 620±10 nm, an emission in the region of 750±5 nm and a 80±10 ns lifetime.

32. The method of claim 31, wherein step (b) comprises illuminating of said luminescent data storage medium with said optical source having a wavelength at 620±50 nm in condition of multi-photon absorption.

33. The method of claim 31, wherein said luminescent data storage medium has an orientation of the optical c-axis parallel to the direction of the light propagation of said optical source.

34. The method of claim 31, wherein said luminescent data storage medium has an orientation of the optical c-axis perpendicular to the direction of the light propagation of said optical source and wherein the vector of polarization of said optical source rotates synchronously with the rotation of said luminescent data storage medium, and wherein said c-axis of the crystal maintains parallel to the polarization direction of the optical source.

35. An apparatus comprising:

a luminescent data storage medium comprising Al_2O_3;

an optical source for writing information to said luminescent data storage medium; and

a means for rotating said luminescent data storage medium and means for rotating of the vector of polarization of said optical source, wherein an optical *c*-axis of said luminescent data storage medium rotates synchronously and is parallel to the vector of polarization of said optical source.

36. An apparatus comprising:

a luminescent data storage medium comprising Al_2O_3;

a first optical source for exciting said luminescent data storage medium to thereby cause said luminescent data storage medium to emit a fluorescent light signal when information is stored on said luminescent data storage medium;

measuring means for measuring said emitted fluorescent light signal; and

a means for rotating said luminescent data storage medium and means for rotating of the vector of polarization of said optical source, wherein an optical *c*-axis of said luminescent data storage medium rotates synchronously and is parallel to the vector of polarization of said optical source.

37. The apparatus of claim 36, further comprising:

a second optical source for writing information to said luminescent data storage medium.

38. The apparatus of claim 37, wherein said first and second optical sources are the same.

39. The apparatus of claim 38, wherein said measuring means include a confocal detection means.

40. The apparatus of claim 37, further comprising an optical head including said first optical source and said second optical source.

41. An apparatus comprising:

a luminescent data storage medium comprising Al_2O_3; and

an optical source for erasing information from said luminescent data storage medium; and

means for rotating a vector of polarization of said optical source, wherein an optical *c*-axis of said luminescent data storage medium rotates synchronously and is parallel to the vector of polarization of said optical source.